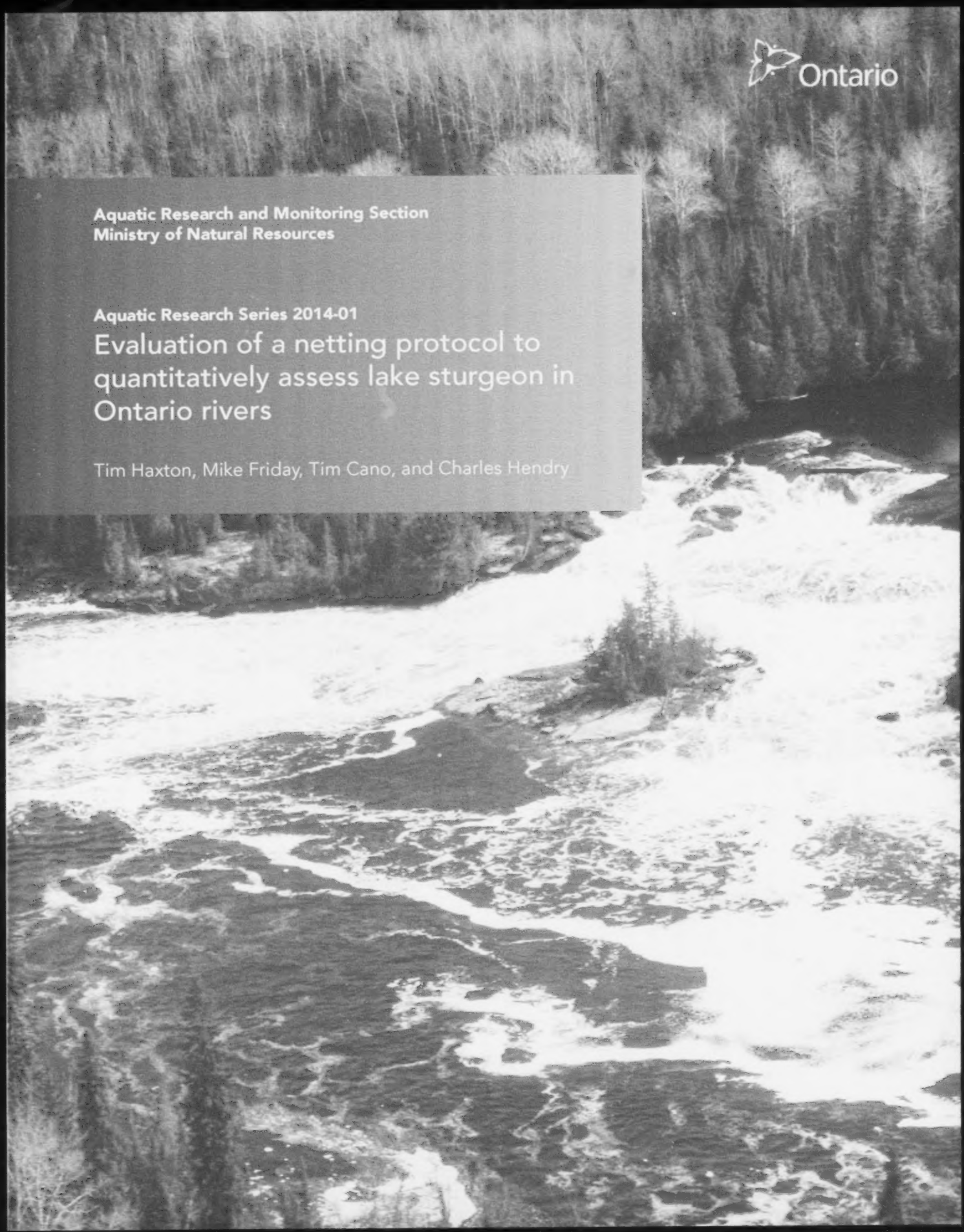

Ontario

Aquatic Research and Monitoring Section
Ministry of Natural Resources

Aquatic Research Series 2014-01

Evaluation of a netting protocol to quantitatively assess lake sturgeon in Ontario rivers

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January 2014

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© 2014, Queen's Printer for Ontario
Printed in Ontario, Canada

ISBN 978-1-4606-3536-0 (PDF)

This publication was produced by:

Aquatic Research and Monitoring Section
Ontario Ministry of Natural Resources
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Peterborough ON K9J 8M5

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Online link to report can be found at:
Ontario.ca/aquaticresearch

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This technical report should be cited as follows:
Haxton, T., M. Friday, T. Cano and C. Hendry. 2014. Evaluation of a netting protocol to quantitatively assess lake sturgeon in Ontario rivers. Ontario Ministry of Natural Resources. 10 pp + appendices.

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Evaluation of a netting protocol to quantitatively assess lake sturgeon in Ontario rivers

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Abstract

The objective of this study was to evaluate an index netting protocol to quantitatively assess lake sturgeon in Ontario. Large mesh (38–127 mm stretched mesh, 1.8 m height) and extra-large mesh (204–306 mm stretched mesh, 1.8 m height) gillnets were used following the Riverine Index Netting (RIN) protocol. Additional modifications were tested based on field practioners' advice, including use of multifilament large mesh gillnets, and selecting the deeper sections of the river to increase lake sturgeon catch. Overall, 362 lake sturgeon were captured in 849 net sets. The large mesh nets and the extra-large mesh nets were selective to 5–10 yr old and greater than 22 yr old sturgeon, respectively. Protocol modifications did not increase lake sturgeon catch. The probability of capturing juvenile and adult lake sturgeon was greatest at the 1–3 m and 3–6 m depth strata, respectively. Additionally, gear calibration should be conducted to determine if the observed lake sturgeon catch was representative of the populations, and to correlate catch (i.e., catch per unit effort) with lake sturgeon density. Power analyses suggest that two years of prior sampling before a management change would be the best scenario to detect a two-fold increase in lake sturgeon abundance and would require less netting intensity and effort post mitigation. The use of large mesh (1.8 m height) and extra-large gillnets and adhering to the RIN protocol was an effective means for evaluating lake sturgeon.

Résumé

L'objet de cette étude était d'étudier un protocole d'index des poissons pris au filet pour évaluer la quantité d'esturgeons jaunes en Ontario. Des filets à grand maillage (mailles étirées de 38 à 127 mm, hauteur de 1,8 m) et à très grand maillage (mailles étirées de 204 à 306 mm, hauteur de 1,8 m) ont été utilisés conformément au protocole d'index des poissons des rivières pris au filet (RIN). Suivant les conseils des praticiens, d'autres modifications ont fait l'objet d'essais, y compris utilisation de filets maillants multifilaments à grandes mailles, et sélection des sections les plus profondes de la rivière pour augmenter les prises d'esturgeons jaunes. En tout, 362 esturgeons jaunes ont été capturés dans 849 filets. Les grands et très grands filets visaient à sélectionner des esturgeons de 5 à 10 ans et de plus de 22 ans, respectivement. Les modifications apportées au protocole n'ont pas augmenté la quantité d'esturgeons jaunes capturée. La probabilité de capturer des esturgeons jaunes jeunes et adultes était plus élevée à une profondeur de 1 à 3 m et de 3 à 6 m, respectivement. Par ailleurs, il faudrait procéder à une calibration du matériel afin de savoir si la prise d'esturgeons jaunes représentait bien les populations et d'établir une corrélation entre la prise (c.-à-d. CPUE) et la densité d'esturgeons jaunes. Selon les analyses énergétiques, le prélèvement d'échantillons pendant les deux ans qui précèdent une modification de gestion serait le meilleur moyen de détecter toute augmentation de deux ordres de grandeur du nombre d'esturgeons jaunes et diminuerait l'intensité des prises au filet et des efforts après l'application de mesures d'atténuation. L'utilisation de filets à grand et très grand maillage (1,8 m de haut) et le respect du protocole (RIN) ont été des moyens efficaces pour évaluer les esturgeons jaunes.

Acknowledgements

We thank Kim Armstrong, Jay Wright (Northwest Biodiversity and Monitoring Section), Jeff Amos, Kevin LeBlond (Northeast Biodiversity and Monitoring Section), and Steve Vandermeer (Southern Biodiversity and Monitoring Section) who were instrumental in the implementation of the field component of this document. Special thanks go out to the field crews involved in the project. We also thank Nick Jones, Steve McGovern, and Kim Armstrong for their review of this report. Funding for this study was provided by the Renewable Energy Section, Species at Risk Branch, and Science and Information Resource Division.

Introduction

Lake sturgeon (*Acipenser fulvescens*) have become the focus of monitoring programs in many jurisdictions, partially because of their status under the Endangered Species Act, in attempts to understand population structure, status, and to evaluate the effectiveness of management efforts. A myriad of techniques, including trapnets, hoopnets, gillnets, setlines, and electrofishing have been employed to target different life stages. Even within gear type, variation in the standards employed within jurisdiction has been observed based on the project or local goals. The need to standardize sampling across a broader range, to support comparisons among waterbodies, regions and agencies within a species range, has been well articulated (e.g., Bonar et al. 2009).

Lake sturgeon are listed as threatened under the Ontario Endangered Species Act (ESA). The Northwestern Ontario population and the Great Lakes-Upper St. Lawrence River population of Lake Sturgeon are classified as threatened and therefore afforded protection. The Hudson Bay-James Bay population is classified as special concern (Golder 2011). As a result of this listing, lake sturgeon receive species (section 9) and habitat protection (section 10) under the ESA. At existing hydro-electric facilities where operations are known to affect lake sturgeon, proponents can enter into an agreement to mitigate the impact thereby taking reasonable steps to reduce the effects on the species. Monitoring is a key component to ascertain the effectiveness of the mitigation. Concurrently, lake sturgeon population trends also require monitoring to assess trajectories and effectiveness of management strategies for achieving recovery goals.

In Ontario, several index netting protocols can be used to assess lake sturgeon. The Riverine Index Netting (RIN) protocol was developed and used to assess riverine fish communities in Ontario (Jones and Yunker 2010, 2011). The RIN protocol uses three net types to target different segments of the fish community and body sizes of fish. The large mesh component (38 mm–127 mm stretched mesh monofilament, 0.9 m panel height) was designed to target large bodied fish including juvenile lake sturgeon (Jones and Yunker 2010). A Broadscale Monitoring (BsM) program was initiated in 2008 on inland lakes in Ontario using the North American gillnet (NAG) as the large mesh standard (Lester et al. 2009). The NAG are identical to the RIN large mesh nets except the panel height is 1.8 m (Jones and Yunker 2011, Appendix A). The Ottawa River, Ontario was assessed as part of the BsM program during which the NAG was noted to be an effective means for sampling juvenile lake sturgeon (Haxton 2011). Therefore, the NAGs in conjunction with the extra-large mesh gillnets used in RIN, following the RIN protocol (Jones and Yunker 2010, 2011) were used as part of a landscape project over a two year period to quantify the effects of hydro-electric facilities on lake sturgeon abundance in Ontario (Haxton et al. ***in review***). The NAGs were used to target juvenile lake sturgeon while the extra-large mesh gillnets were used to target adult lake sturgeon. During that project, a few modifications to the netting protocol, as recommended by field practitioners as means to improve the catch of lake sturgeon, were tested (e.g., use of multifilament mesh for the large mesh nets; selectively targeting deeper sections of the rivers). However, concerns were raised that by-catch may increase with the use of multifilament mesh for the large nets. The objective of this study was to determine the suitability of using the RIN protocol to assess lake sturgeon populations. More specifically, we assess the lake sturgeon catch for each net type to ascertain the segment of the lake sturgeon population they target. We conduct power analyses on both the large mesh and extra-large mesh gillnets to determine the effort required to detect a 100% increase in lake sturgeon abundance. We assess the effectiveness of protocol modifications at increasing lake sturgeon catch including ascertaining the depth of greatest probability for capturing a lake sturgeon. Finally, we assess the effect of gear modification (e.g., monofilament vs. multifilament) on by-catch.

Methods

The NAGs and extra-large multifilament gillnets (204–306 mm stretched mesh multifilament; Appendix A) technique were used on medium to large rivers within Ontario (Table 1) following the RIN protocol. The NAGs were used to specifically target the juvenile segment of the population, whereas extra-large mesh gillnets were used to target adult lake sturgeon. The extra-large mesh gillnets were essentially developed for commercial fisheries and had been adopted by MNR and subsistence fishers to target adult lake sturgeon. A few modifications to the protocol to improve lake sturgeon catch rates were attempted in year two of the study including selecting the deeper sections

of a river within a randomly selected quadrant, and using multifilament mesh in a paired comparison test with the North American gillnet. Full details on site selection are provided in Haxton et al. (*in review*).

Table 1. Sites included within the study detailing hydro-electric water management regime, year, number of nets set, number of lake sturgeon sampled and mean total length with associated variation.

Waterbody	Site	Region	Year	# net set		# lake sturgeon caught	Mean size (± SD) (mm)
				large mesh	x-large mesh		
Abitibi River	Long Sault Rapids GS to Island Falls GS	NE	2010	40	19	6	652 (511)
	Island Falls GS to Abitibi Canyon GS	NE	2010	32	14	16	748 (290)
	Abitibi Canyon GS to Otter Rapids GS	NE	2010	38	19	28	518 (268)
Berens River		NW	2010	11	9	11	768 (236)
Black Sturgeon River		NW	2010	0	19	3	1262 (166)
Groundhog River		NE	2010	32	16	6	1174 (236)
Kaministiquia River		NW	2010	12	23	9	1291 (179)
			2011	18	14	12	917 (418)
Kenogami River	btw Kabinagagami and Drowning R.	NE	2011	17	9	45	614 (252)
	Ogahalla L.	NW	2011	8	11	19	1199 (111)
	Chipman L.		2011	22	5	14	1268 (123)
Mattagami River	Kipling GS to Adam Creek	NE	2010	16	8	11	748 (295)
	Little Long Reservoir	NE	2010	31	16	5	1254 (120)
	btw Sandy Falls GS and Lower Sturgeon Falls	NE	2011	30	23	12	679 (229)
Mississagi River	Tunnel Lake	NE	2010	16	8	0	
	Redrock Lake and upstream		2010	16	7	0	
Namakan River		NW	2010	51	20	38	984 (286)
			2011	55	25	52	
Ottawa River	Lac Coulonge	SR	2010	33	16	31	651 (202)
	Lac des Chats		2010	21	9	4	905 (416)
Seine River		NW	2010	27	10	1	293
Spanish River	Espanola to Nairn Centre	NE	2010	25	11	0	
	Nairn Centre High Falls	NE	2010	16	8	0	

Net location selection

Netting sites within a river were selected by placing a grid (block size of either 250 or 500 m and generally based on size of river) over the river and randomly selecting a block using Hawth's Tools in ArcMap. There were no depth restrictions within the study (i.e., the design was not depth stratified) and therefore a variety of depths would have been represented through random selection. However, given the purported proclivity of lake sturgeon to select deeper areas within rivers, nets were set in the deeper sections of the selected block in year 2. Sites that were less than two metres deep were not fished.

RIN protocol restrictions inhibited net placement within 250 m of each other. Netting sites were re-used if site selection was limited within the river and the block had been randomly reselected, however, they were not re-used within a 48 hour period (Jones and Yunker 2010).

Netting

Generally, eight netting nights were expended on each river. Four large mesh nets (38–127 mm stretched mesh monofilament gillnet [i.e., North American gillnets]) and two extra-large mesh nets (204–306 mm stretched mesh monofilament gillnet) were set each night to target juvenile and adult lake sturgeon, respectively. Nets were set perpendicular to the shore where flows permitted, or angular (e.g., 45°) where flows were deemed substantial enough to impede the effectiveness of a perpendicular set. Nets were secured to shore when deemed necessary however, this was not a common practice. Nets were fished for 22 hours (minimum 18 hours, maximum 26 hours). Netting was conducted from mid-September until the end of October, generally when water temperatures were greater than 13°C.

Monofilament vs multifilament large mesh nets

To compare netting efficacy for lake sturgeon among monofilament and multifilament large mesh nets, monofilament and multifilament nets were set within 500 m of each other in as similar habitat as possible (e.g., depths, flows, substrate). Multifilament gillnets were constructed with the identical mesh sizes and order of mesh sizes within a panel. Unpaired multifilament net sets were not included in the aforementioned analyses. However, a comparison was made between lake sturgeon catch per unit effort (CUE) in monofilament versus multifilament nets by grouping net types to ascertain if consistent results were obtained.

Catch sampling

Lake sturgeon were extricated from gillnets, sampled and released when possible. Lake sturgeon were sampled for total length (to the nearest mm), fork length, and weight (nearest 100 g). A section of the leading pectoral ray was removed (approximately a 1 cm section extracted approximately 2 mm from the articulation using a 24/1 tooth hacksaw) according to Wilson (1987) and sent to MNR's aging lab (Dryden, ON) for age interpretation.

Statistical analysis

Paired *t*-tests were conducted to analyze lake sturgeon CUE data between monofilament and multifilament gillnets and then all fish CUE between the paired nets sets. A negative binomial regression was conducted to analyze lake sturgeon CUE between all monofilament and multifilament gillnet sets. A Generalized Linear Model with a negative binomial family and a log link using lake sturgeon CUE as the dependent variable and mesh type as the predictor were used in the analysis.

To assess probability of capturing a lake sturgeon at different depths, a binomial distribution was fitted using the number of nets with at least one sturgeon captured within a depth stratum as the success and the total number of nets set within that success as the trials. Probability of capture was determined for both large mesh and extra-large mesh gillnets. In addition, negative binomial regression was used to determine if there was an effect of depth on the number of lake sturgeon sampled (i.e., abundance) for both large mesh (juvenile) and extra-large mesh (adult) nets. Non-informative priors (N(0,1000)) were used in all analyses. Nets were classified to depth strata as outlined in the BsM protocol (1–3 m; 3–6 m; 6–12 m; 12–20 m; and 20–35 m) as they were generally set over a depth range. Bayesian analysis using OpenBugs (http://www.mrc-bsu.cam.ac.uk/bugs/) were used for the aforementioned analyses. A Markov-chain Monte Carlo (MCMC; two chains, 100 000 iterations, 10 000 burn in period) was used for simulation. Model convergence was assessed for each run by plotting the sample value against the iteration number (i.e., history) to ensure there was stationary distribution. In addition, the posterior distribution was assessed for normality (i.e., density) and autocorrelation.

Power Analysis

Power analysis was conducted to determine the sample size required to detect a two fold increase in lake sturgeon abundance in regulated reaches based on number of sampling events. In this case, sample size was the number of

nets set annually, and the number of sampling events pertains to the number of years which may not necessarily be consecutive. To determine the sample size required, significance was established at $P = 0.05$, power was set at 0.80, and the CUE with associated error was used from the regulated reach netting results (both large mesh and extra-large mesh nets separately). Scenarios were run with one and two years baseline data (i.e., pre-modification).

Non-Bayesian statistical analyses were conducted using Stata v 12 (StataCorp LP, College Station, TX). Significance was determined at $P<0.05$.

Results

Twenty-three locations supporting lake sturgeon were netted across the province in 2010 and 2011 (Figure 1; Table 1). Overall, 3075 fish encompassing 24 species were sampled in the large mesh nets with lake sturgeon representing 5.2% of the catch. Extra-large mesh nets sampled 182 fish encompassing 9 species with lake sturgeon representing 86.8% of the catch. There were 849 net sets (517 large mesh nets and 332 extra-large mesh nets) that sampled 362 lake sturgeon (204 from large mesh nets and 158 from extra-large mesh nets [Table 1]) with a mean total length of 870 mm (range 214 to 1734 mm) and mean age of 21.6 yrs (range 1–56 yrs). Mean total length of lake sturgeon sampled from large mesh nets was 588 mm (217 SD), and mean age was 11.5 yrs (8.4 SD). In comparison, mean total length of lake sturgeon sampled from extra-large mesh nets was 1160 mm (200 SD) and mean age was 29.3 years (10.2 SD). Large mesh nets were selective to juvenile lake sturgeon (ages 5–10) whereas the extra-large mesh nets were selective to adult lake sturgeon (ages > 22 yrs; Figure 2). The observed mortality rate of lake sturgeon caught in gillnets was 1.5%.

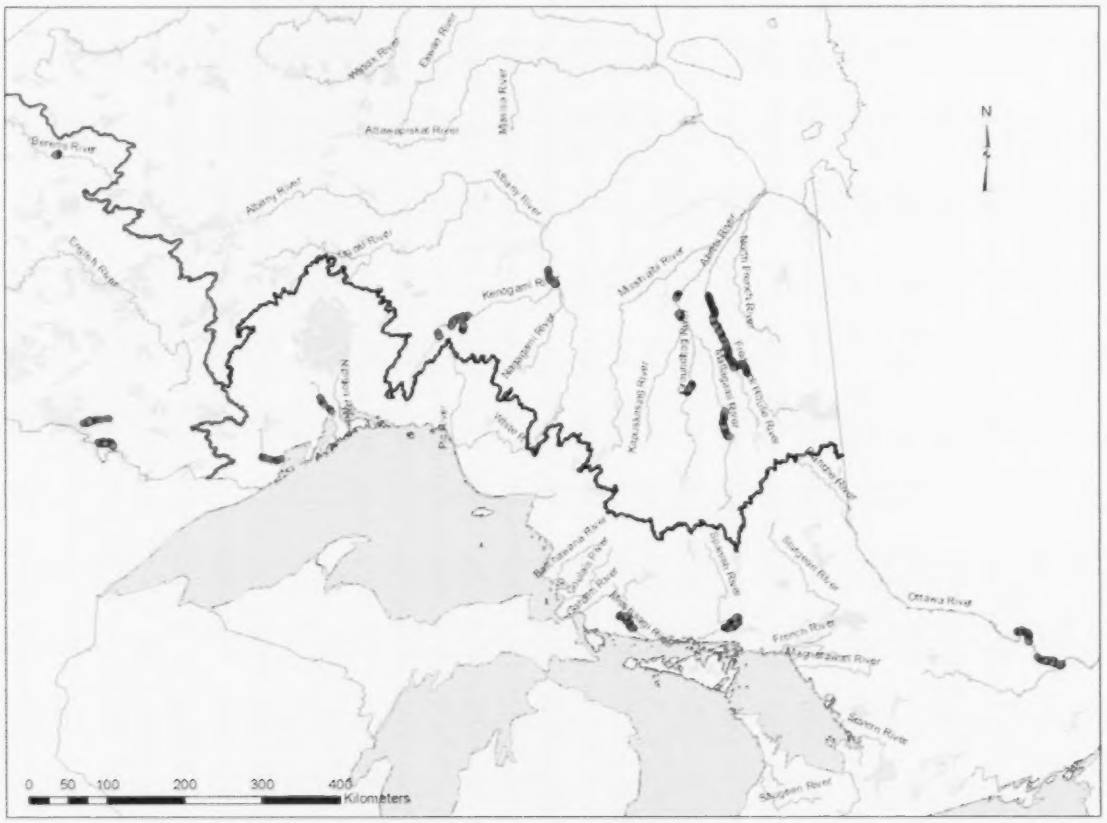

Figure 1. Sampling locations included in the lake sturgeon netting assessment program with each dot represents a netting site. The dark brown line represents the Winnipeg River drainage, whereas the black line represents the Great Lakes/St. Lawrence drainage. Areas north of these lines represent the Hudson Bay drainage.

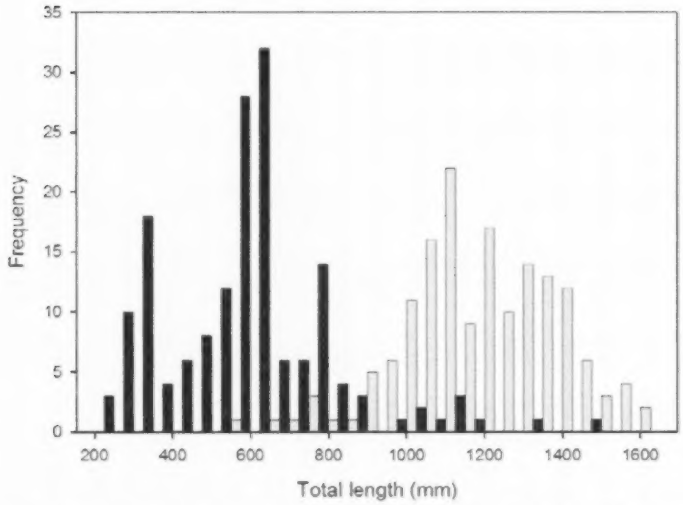

Figure 2. Length frequency distribution of lake sturgeon sampled in large mesh (black bars) and extra-large mesh (gray bars).

Monofilament vs multifilament large mesh nets

In total, 43 paired large mesh nets were set in various rivers in 2011 capturing 9 lake sturgeon in the monofilament nets and 11 in the multifilament nets. In comparison, 436 fish of 20 species were caught in the monofilament nets and 537 fish of 25 species were caught in the multifilament nets. There was not a significant difference in the catch of lake sturgeon between monofilament and multifilament gillnets (Paired t-test, $t = 0.388$, d.f. = 42, $P = 0.65$, fS= 0.59) however, significantly more fish were caught in the multifilament gillnets (Paired t-test, $t = 2.14$, d.f. = 42, $P = 0.038$). Lake sturgeon CUE between pooled monofilament versus pooled multifilament nets sets were not significantly different (Negative Binomial Regression, $z = 1.62$, d.f. = 106, $P = 0.104$).

Power analysis

The number of net sets (sample size) required to detect a two-fold increase in abundance declined with the number of years sampling post modification using both large mesh (Figure 3) and extra-large mesh (Figure 4) gillnets. Two years of baseline samples would be ideal for assessing effectiveness and would require less netting intensity and effort post mitigation than one year of baseline sampling (Figures 3 and 4).

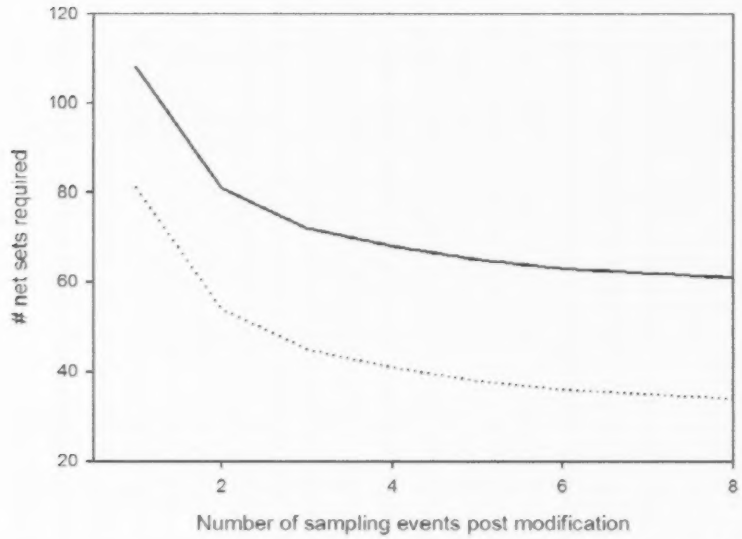

Figure 3. Sample size required to detect a two-fold increase in lake sturgeon abundance in regulated rivers using large mesh gills nets and the associated the number of sampling events post modification based on one (solid line) and two years (dotted line) of baseline sampling (ß = 0.80 and $P = 0.05$).

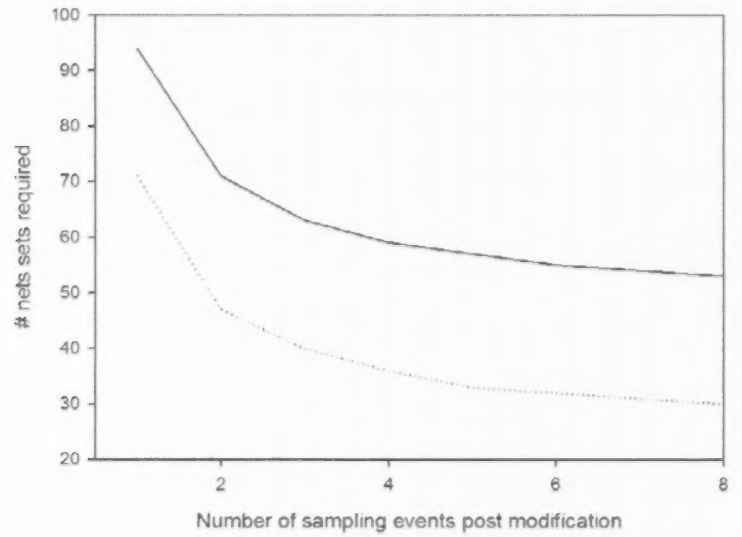

Figure 4. Sample size required to detect a two-fold increase in lake sturgeon abundance in regulated rivers using extra-large mesh gills nets and the associated the number of sampling events post modification based on one (solid line) and two years (dotted line) of baseline sampling (ß = 0.80 and $P = 0.05$).

Depth effect

The probability of capturing at least one juvenile was greatest at the 1–3 m depth stratum (Figure 5) and greatest for adult lake sturgeon at the 3–6 m depth stratum (Figure 6). The CUE of lake sturgeon in large mesh nets was significantly greatest at the 1–3 m (Negative binomial regression, $P<0.05$; Figure 7) whereas in the extra-large mesh nets, the CUE was significantly lowest in the 12–20 m depth stratum but not significantly different among the other depth strata (Negative binomial regression, $P<0.05$; Figure 7).

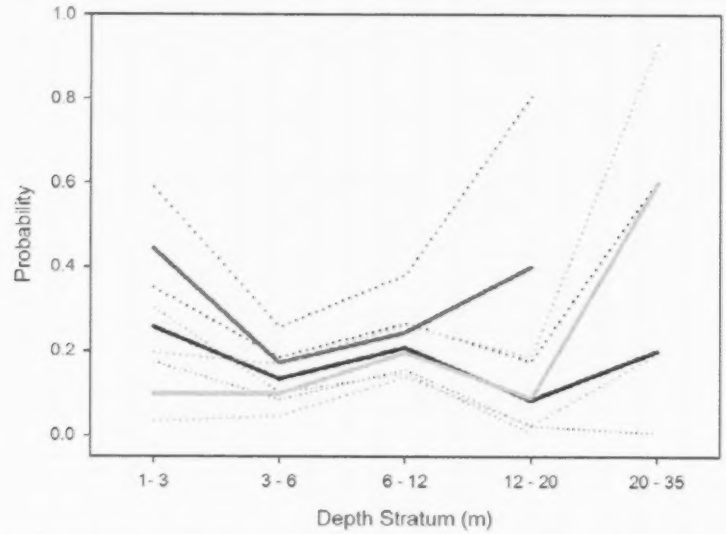

Figure 5. Probability of capturing a juvenile lake sturgeon at different depths. Black represents all large mesh nets combined, purple represents unimpounded rivers, and green represents regulated rivers. Dotted lines represent the 95% credible limits around estimates.

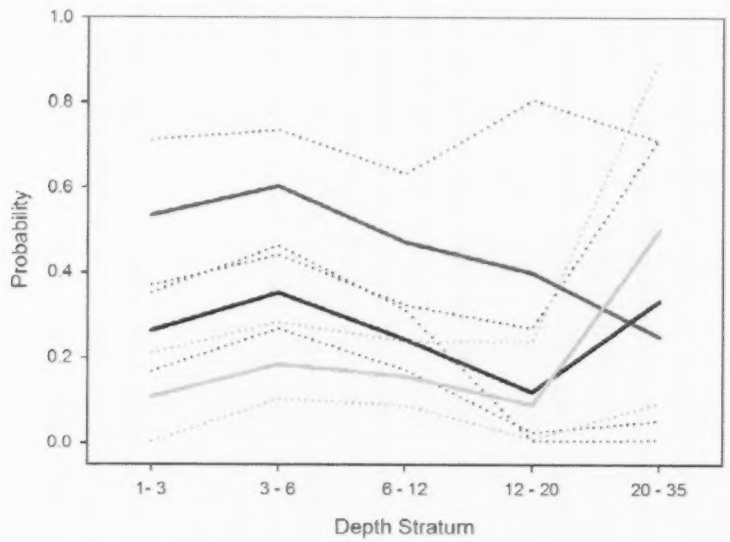

Figure 6. Probability of capturing an adult lake sturgeon at different depths. Black represents all extra- large mesh nets combined, purple represents unimpounded rivers, and green represents regulated rivers. Dotted lines represent the 95% credible limits around estimates.

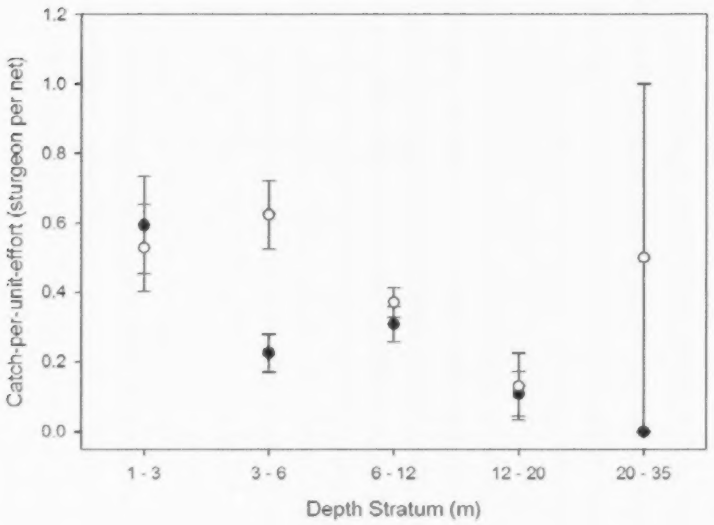

Figure 7. Catch-per-unit effort of juvenile (solid dots) and adult (open dots) lake sturgeon among different depth strata. Error bars represent the standard error.

Discussion

The netting protocol used in this study seemed to be effective for quantitatively assessing juvenile and adult lake sturgeon within rivers in Ontario. Juvenile lake sturgeon were vulnerable to the large mesh nets (i.e., NAGs). Originally, extra-large mesh nets were employed for qualitative (i.e., presence/absence) purposes, as they have never truly been tested for adult lake sturgeon, but proved to be quantitatively effective.

A few modifications to the protocol (e.g., multifilament vs. monofilament gillnet, and depth) were field tested during the second year of the study in attempts to improve lake sturgeon catch rates. The use of multifilament large mesh gillnets was not effective at improving catch efficiency for lake sturgeon, but increased the number of fish caught and species diversity within the nets. Therefore, the choice of using monofilament versus multifilament to target lake sturgeon would depend on the objectives of the projects in terms of assessing the fish community within the river or reducing by-catch within the sample.

Based on advice from field practitioners, nets were set in the deeper sections of the randomly selected grids in the second year of this study. The notion that juvenile lake sturgeon selected deeper holes within the river has been observed within other jurisdictions (Holtgren and Auer 2004, Barth et al. 2011). Juvenile lake sturgeon have been shown to be selective to the 12–20 m depth stratum in large, deep rivers (Lord 2007, Haxton 2011). With the exception of two sections of the Ottawa River included in this study (Lac Coulonge and Lac des Chats), rivers were generally shallower than 20 m. However, juvenile and adult lake sturgeon were not sampled only within the deeper areas of the river but were generally captured in shallower strata. Lake sturgeon have been described as a shallow water species with depth preferences of 4–9 m (Wilson and McKinley 2004). These results emphasize the need for a random approach to setting nets throughout a river as opposed to selecting only deep sections when assessing at the population level.

Sampling was conducted in the fall. This coincided with increased flows and leaf fall, which ultimately affected netting efficiencies, particularly in more northern locales where abscission occurred earlier. However, sturgeon movement is generally greater at this time of the year (Holtgren and Auer 2004, Benson et al. 2005, Shaw et al. 2013) as are catch rates (Miller 2009). Overnight net sets were used in this study as per the RIN protocol (Jones and Yunker 2010) which proved effective for lake sturgeon. Observed mortality rates were low as lake sturgeon are relatively hardy. Overnight nets are imperative for lake sturgeon as diurnal movement patterns is generally greater at night as they move into shallower areas to feed (Chiasson et al. 1997, Holtgren and Auer 2004).

The large mesh gillnet was selective to juvenile lake sturgeon. The mode of capture in terms of lake sturgeon age was five years therefore theoretically, a response in management activities may be detectable within that time frame. This would of course depend on the sturgeon functional response to these management efforts and cohort strength related to environmental variables (Dumont et al. 2011, Shaw et al. 2012). Because the protocol targets juvenile individuals, one would not be required to wait until a response by adults (i.e., > 25 yrs) was detected before effectiveness of mitigation could be ascertained. However, the use of both net sizes would permit assessment of both juveniles and adults. Quantitatively, an agency should be able to detect an effect with adequate sampling (i.e., power). Two years of sampling prior to a mitigation or management change would be best for detecting an effect (if one is present) requiring less annual and long term netting commitment. However, the amount of sampling required would vary based on the river and the variability in catch rates. Power analyses should be conducted progressively through a project to ensure the amount of sampling required to detect an effect is conducted.

During this study, we assumed that we captured a representative portion of the population (i.e., juveniles and adults) from the protocol employed. However, this assumption remains un-validated. Also, although we infer relative abundance from the netting protocol, we were unable to correlate with absolute abundance or density of lake sturgeon in the river. Both of these remain science needs for the netting protocol. Finally, the gear types were selective to juvenile and adult lake sturgeon; for the most part, sub-adult lake sturgeon were absent within the samples. While this segment of the population was not the focus of this study, the netting protocol would not provide a true assessment of the lake sturgeon population if that was the primary objective. Incorporating 152 mm and 178 mm stretched mesh as part of nets would help target the missing segment of the population as was evident when using a different protocol that included these mesh sizes when conducting sturgeon assessment on the Ottawa River (Appendix B). Additionally, inclusion of these mesh sizes may target age cohorts missing in slower growing populations.

Conclusions

The use of large mesh nets (38–27 mm stretched mesh monofilament gillnet, 1.8 m height [i.e., North American gillnets]) and extra-large mesh nets (204–306 mm stretched mesh multifilament gillnet, 1.8 m height) while adhering to the RIN protocol were an effective means to quantitatively assess juvenile and adult lake sturgeon in Ontario rivers. For effectiveness monitoring, two years prior sampling is recommended to provide the power necessary to detect an effect of a management (e.g., flow manipulation, spawning shoal construction, etc.) change. However, before the use of the NAG can be recommended as a standard to target lake sturgeon in rivers, a comparative study to ascertain the efficacy of RIN versus NAG nets is required. Likewise, the 152 mm and 178 mm mesh sizes should be incorporated into the net design and tested to target sub-adults or cohorts not selective to the gear in slower growing populations. Finally, gear calibration should be conducted to determine if the observed lake sturgeon catch was representative of the populations, and to correlate catch (i.e., CUE) with lake sturgeon density.

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Appendix A. Specifications of gillnets used within the study

	Large mesh gillnet							
Stretched measure (in)	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Stretched measure (mm)	38	51	64	76	89	102	114	127
Mono diameter (mm)	0.28	0.28	0.28	0.33	0.33	0.33	0.40	0.40
Series order	5	3	7	1	4	8	2	6
Panel length (m)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Panel length (ft)	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Panel height (m)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Panel height (ft)	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Mono colour	clear							
Float line	13 mm (1/2 in)							
Lead line	no. 27 (27 lbs/300 ft)							
Mesh labels	yes (mm)							

from Sandstrom et al. (2009)

	Extra-large mesh gillnet			
Stretched measure (in)	8	9	10	12
Stretched measure (mm)	240	230	255	306
Twine size	210/12	210/12	210/12	210/12
Series order	3	1	4	2
Panel length (m)	6.2	6.2	6.2	6.2
Panel length (ft)	20.3	20.3	20.3	20.3
Panel height (m)	2.13	2.13	2.13	2.13
Panel height (ft)	7	7	7	7
Line	green twine, double knotted, multifilament nylon			
Float line	13 mm			
Lead line	no. 27 (27 lbs/300 ft)			
Mesh labels	yes (mm)			

from Jones and Yunker (2010)

Appendix B

Figure B.1 illustrates the gear selectivity of two different nets sizes used on the Ottawa River. Fall Walleye Index Netting (FWIN) uses a standard nets that is comprised of panels of 25 mm, 28 mm, 51 mm, 64 mm, 76 mm, 102 mm, 127 mm, and 152 mm monofilament mesh each 7.6 m long, 1.8 m deep. The Sturgeon nets were comprised of panels of 178 mm, 203 mm, 229 mm, 267 mm and 305 mm monofilament mesh, each 15.2 m long, 1.8 m deep.

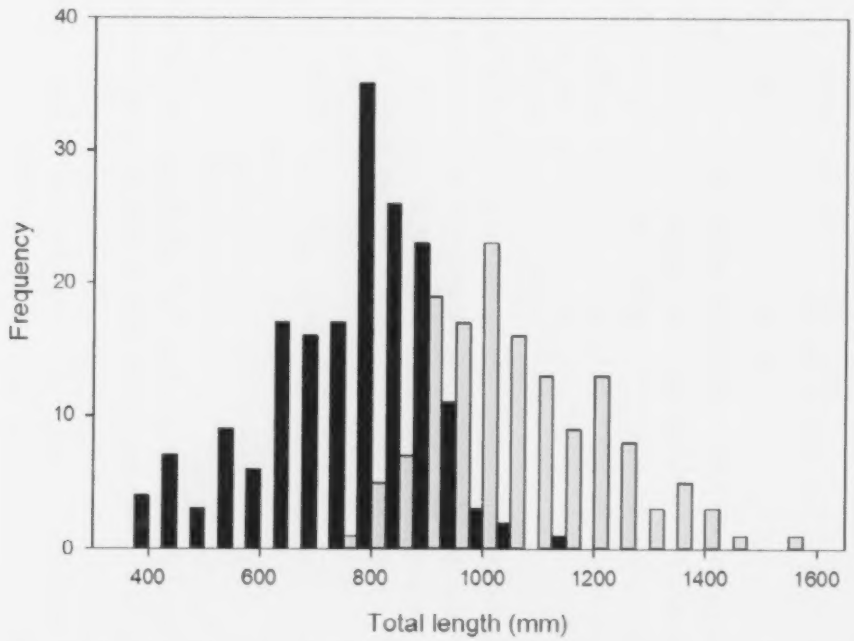

Figure B.1 Length frequency distribution of lake sturgeon sampled in FWIN (black bars) and Sturgeon nets (grey bars).

ISBN: 978-1-4606-3536-0

January 2014